

AMRL-TR-71-126

AD 746 661



A RESTRAINT SYSTEM FOR SQUIRREL MONKEYS

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MAY 1972

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20050405076

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AEROSPACE MEDICAL DIVISION
AIR FORCE SYSTEMS COMMAND
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DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)

Science Research Institute
Oregon State University
Corvallis, Oregon 97331

2a. REPORT SECURITY CLASSIFICATION

UNCLASSIFIED

2b. GROUP

N/A

3. REPORT TITLE

A RESTRAINT SYSTEM FOR SQUIRREL MONKEYS.

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

5. AUTHOR(S) (First name, middle initial, last name)

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D. E. Johnson
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6. REPORT DATE

May 1972

7a. TOTAL NO. OF PAGES

10

7b. NO. OF REFS

8

8a. CONTRACT OR GRANT NO. AF33615-67-C-1787

b. PROJECT NO. 7163

c.

d.

9a. ORIGINATOR'S REPORT NUMBER(S)

9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

AMRL-TR-71-126

10. DISTRIBUTION STATEMENT

Approved for public release; distribution unlimited.

11. SUPPLEMENTARY NOTES

12. SPONSORING MILITARY ACTIVITY

Aerospace Medical Research Laboratory,
Aerospace Medical Division, AFSC, Wright-
Patterson Air Force Base, Ohio 45433.

13. ABSTRACT

Figures 1 through 4 illustrate the details of the design and construction of the restraint chair, and permit visualization of the device in use. Materials of construction are acrylic plastic, nylon, aluminum and stainless steel. All edges contacting the animal are fire polished. Dimensions of the components are tabulated at the end of this section.

Key Words:

Restraint system
Squirrel monkeys

FOREWORD

The apparatus described was developed in the course of a study initiated and co-sponsored by the Aerospace Medical Research Laboratory, Aerospace Medical Division, Wright-Patterson AFB, Ohio 45433, and the Life Sciences Division of the Office of Aerospace Research, Arlington, Virginia 22209. The research was performed in accordance with the Contract No. AF33615-67-C-1787 in support of Project 7163, "Research on Biomechanisms and Metabolism." Drs. C. H. Wang and F. N. Dost were principal investigators for the Science Research Institute, Oregon State University, Corvallis, Oregon 97331. Dr. Kenneth C. Back, Chief, Toxicology Branch, Toxic Hazards Division was the contract monitor for the Aerospace Medical Research Laboratory. The research program was initiated 1 July 1967 and completed 30 August 1970.

This technical report has been reviewed and is approved.

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INTRODUCTION

Among primates suitable as experimental animals in biochemical, pharmacological, and toxicological research, the squirrel monkey (*Saimiri sciureus*) has advantages of small size, low cost, and inexpensive maintenance. However, vigorous resistance of this species to conventional subchronic or chronic restraint methods has limited its use in experiments where excitement or apprehension may compromise the data. The wide variations in respiratory and cardiac activity of restrained squirrel monkeys observed by Beisher and Furry illustrate the problem (1).^{*} In spite of this disadvantage, our requirements for use of a small primate in extended studies of glucose catabolism have led us to seek a procedure allowing employment of squirrel monkeys free from excitement over periods of several hours, and hopefully several days.

A number of relatively long term experimental confinements of squirrel monkeys are recorded, but these experiments have utilized a few animals and an intensive training program. The best examples are found in the preparation for and execution of space flight experiments (2,3,4). Other confinement systems (5,6,7,8) have been used for situations ranging from momentary restraint to extended experiments, but all require extended training of the animals. Several months of experience in our laboratory confirmed that methods requiring training were unsuitable for metabolic studies. As an alternative it appeared desirable to design a restraint system oriented to the behavioral character of the species, as well as to its anatomical peculiarities.

The experiments in this laboratory with squirrel monkeys call for continuous infusion of ¹⁴C labeled substrates subcutaneously or intraperitoneally over periods of 8 to 16 hours, with the capability for continuous collection of respiratory gases. The minimum acceptable period of stable restraint without excitement was therefore considered to be 18 hours. It was assumed that fluid and nutrient balance could, in most cases, be maintained by the infusion, but provision for feeding and watering was considered essential nonetheless.

The system we have designed in response to these needs exerts primary restraint at the waist, avoiding the usual limitation to free movement of the head and neck, and is well tolerated by squirrel monkeys. In experiments up to 18 hours the procedure is satisfactory and apparently does not cause appreciable apprehension on the part of the subjects.

DESCRIPTION OF THE SYSTEM

Figures 1 through 4 illustrate the details of the design and construction of the restraint chair, and permit visualization of the device in use. Materials of construction are acrylic plastic, nylon, aluminum and stainless steel. All edges contacting the animal are fire polished. Dimensions of the components are tabulated at the end of this section.

^{*}Numbers in parentheses refer to references.

The base plate supports the four-rung seat (Fig. 1(A)) and holds the restraining slides. These are two "U" shaped plates which slide past one another to enclose but not grasp the animal at the waist, regardless of size (Fig. 2(A), 3(A)). Vertical movement is thus limited by the rib cage and hips. The buttressed seat support may be fixed to either side of the base plate, so that either side of the subject may be accessible.

The torso passes through the upper support plate, which has an aperture barely large enough to pass the head and shoulders of the animals (Fig. 3(B)).¹ In our practice, the hands and head of the monkey are usually free within the dome. A respiration dome may be seated directly on the upper support plate for use either for continuous collection of respiratory gases or to supply a specific breathing atmosphere (Fig. 4(A)). If the dome is not used, the upper support plate maintains the posture of the subject and prevents it from handling appliances on other parts of the body. A hole is drilled in the side of the dome to accommodate a Lixit® drinking fixture (ATCO Mfg. Co., Napa, California) for experiments of more than a few hours. When the dome is not used the waterer is attached to the support plate by a clamp.

The leg restrainer (Fig. 4(B)) may be adjusted to fix the leg in any position it is capable of assuming. The leg is confined but not grasped by several spring clips, thereby closely limiting movement with minimum danger of pressure injury. The restrainer may be at the medial or lateral aspect of either leg, and if necessary the opposite leg may be positioned by a second plate. The bracket for the leg restrainer is an 'S' shaped extrusion (Fig. 4(C)) with the horizontal components slotted. A single bolt through one slot to the support plate and a single bolt through the other slot to the leg restrainer provide for universal positioning.

The chair is supported on a single hollow square pedestal, mounted on a floor plate which can be leveled. The square post permits firm positioning of the entire appliance while permitting almost unobstructed access from all sides. This feature also provides immediate adaptation to wall mounting.

Complete disassembly and reassembly for cleaning requires only a few minutes.

Dimensions (in inches)

Base Plate	9 x 12 x 1/2
Aperture	4 x 4
Restraint Slides	5 x 10 x 1/4

¹ Male squirrel monkeys may exceed 1000 grams in weight, while some mature males may weigh as little as 500 grams. For smaller monkeys the upper support plate aperture should be made smaller or fitted with a restraint slide, as on the base plate.

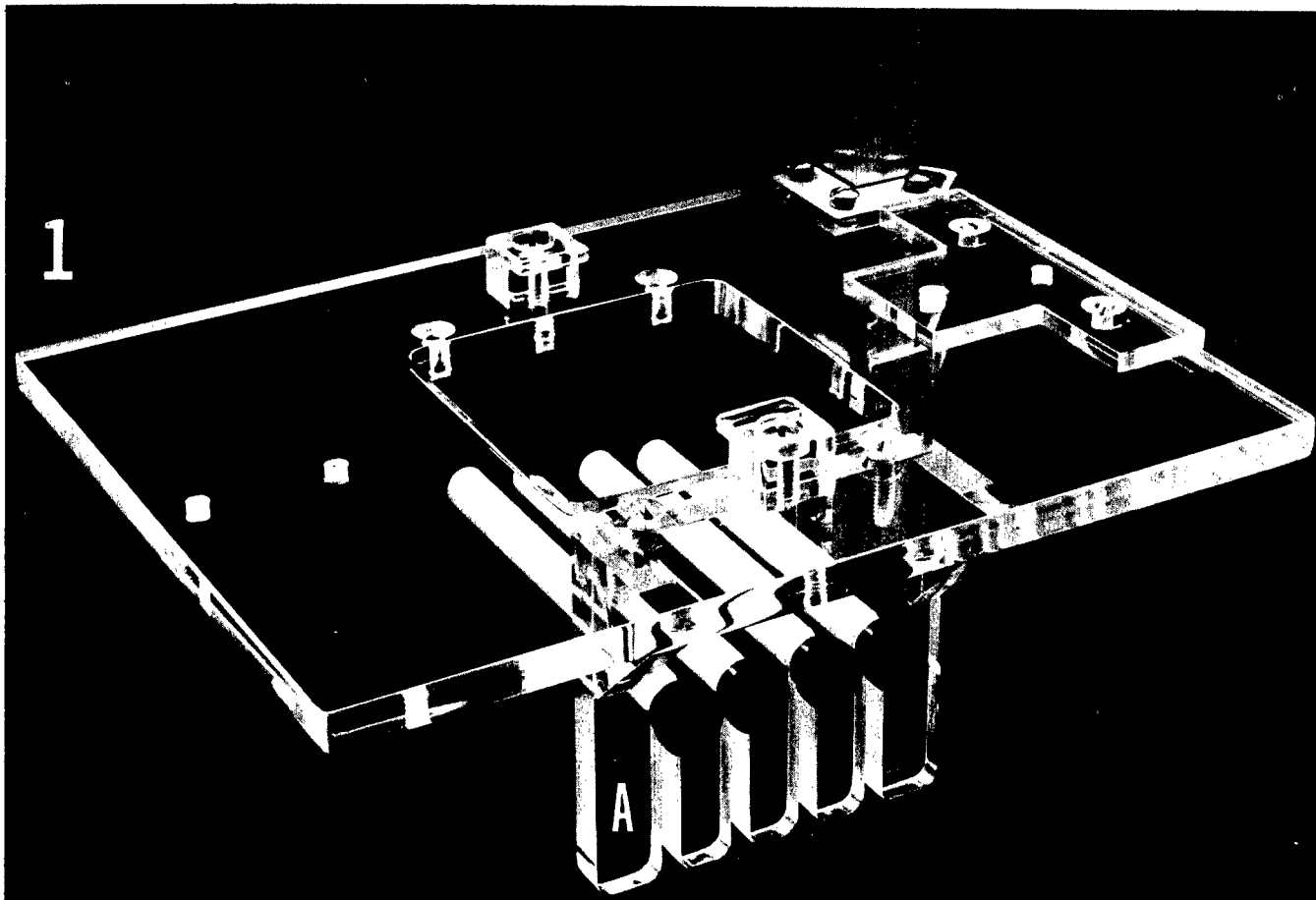


Figure 1

A - Four-rung Seat

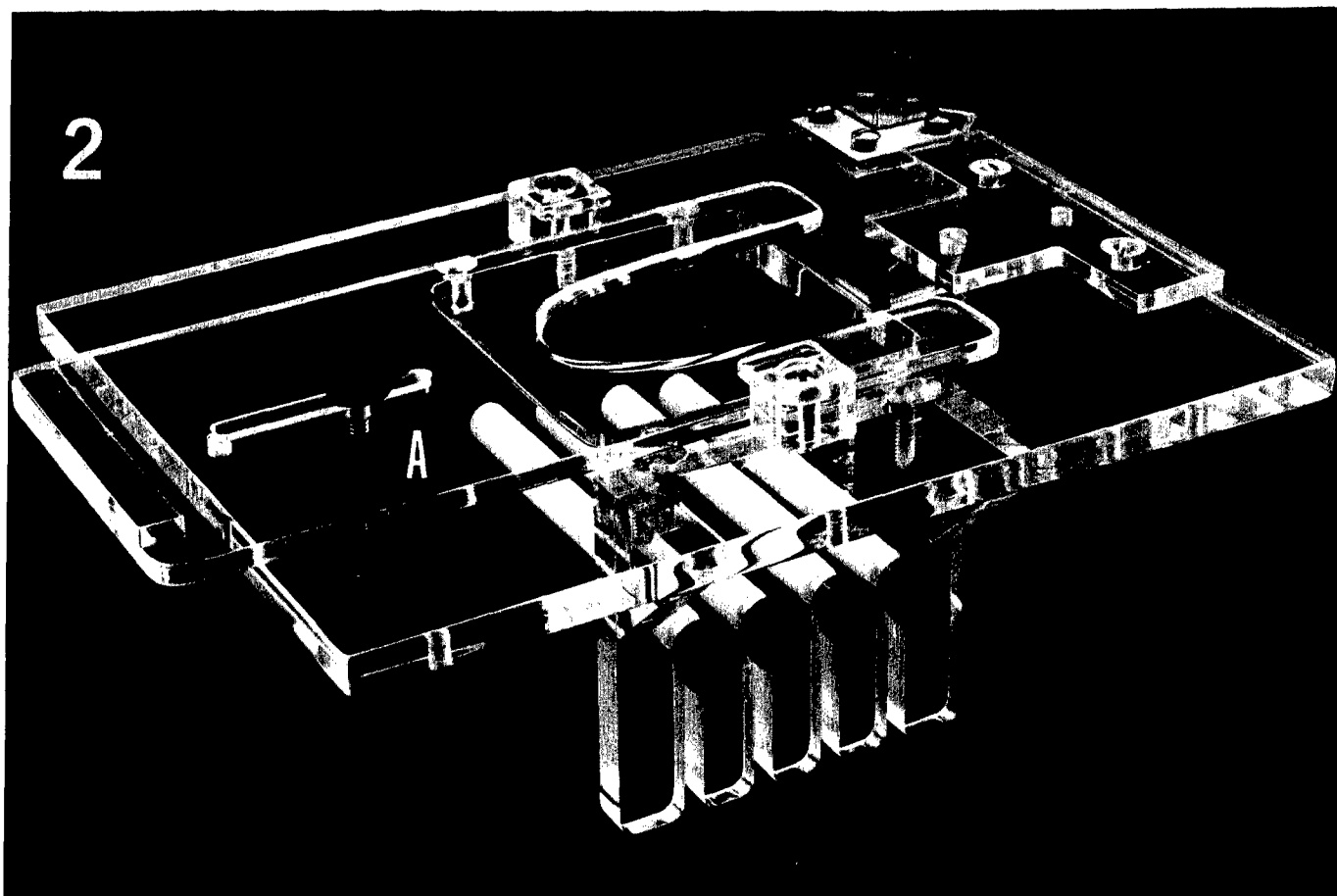


Figure 2

A - Restraint Slide

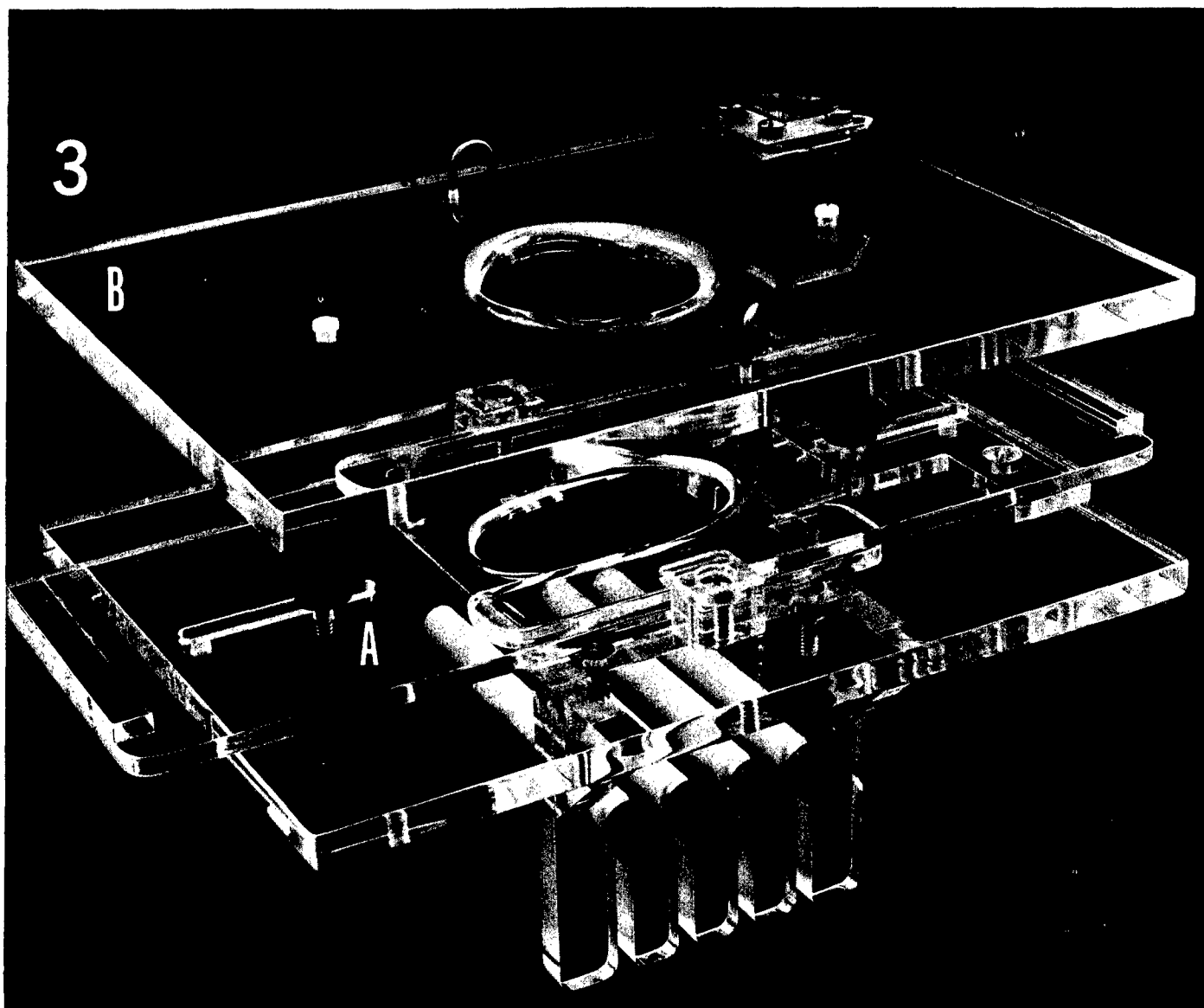


Figure 3

A - Restraint Slides
B - Upper Support Plate

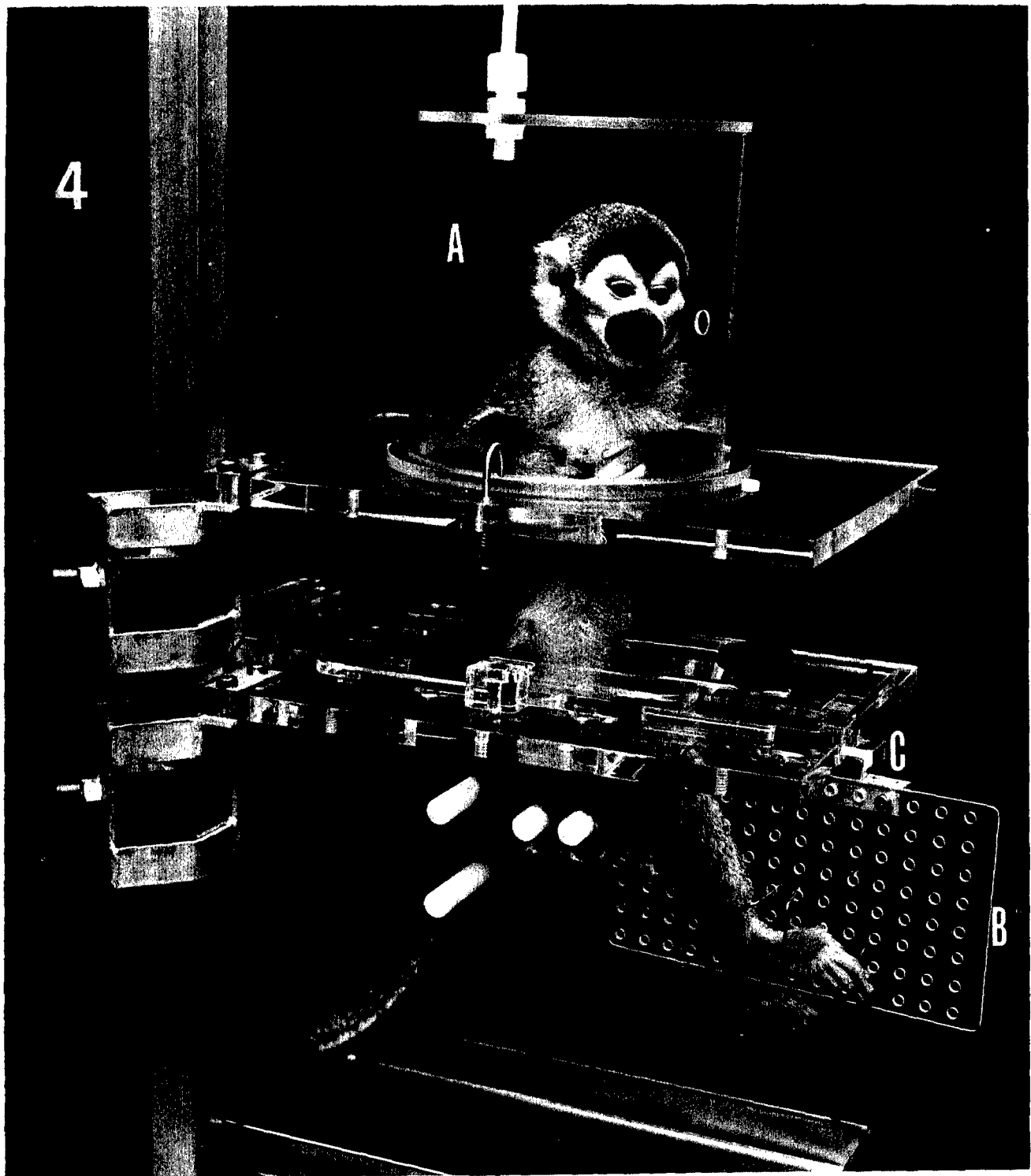


Figure 4

- A - Respiration Dome
- B - Leg Restrainer
- C - Leg Restrainer Bracket

Opening - across tips	2 1/2
depth	4 1/2
Upper Support Plate	9 x 12 x 1/2
Aperture	2 5/8 (dorso-ventral) x 3
Seat Support	4 1/2 x 3 3/4 deep x 1/2, 4 slots
Seat Rungs	1/2 x 4 1/2 (Nylon)
Leg Restrainer	7 1/4 x 4
Perforation Interval	1/2
Dome	6 x 6
Support Post	1 x 1 x 48 (Tempered Aluminum)

USE OF CHAIR

A squirrel monkey can be placed in the chair by one person with little difficulty. The chair is prepared by removing the rungs of the seat and opening the restraining slides. The upper support plate is left in place, without the dome. The monkey is grasped from behind at the waist and brought upward through the base and upper support plates. In most cases the animal moves upward readily; if he is reluctant he can be directed with the free hand. As the monkey moves upward the grasp is shifted to the base of the tail to hold him in position while the slides are closed and fastened. The clearance between slides and body should be checked with the bare fingers, and the animal can be moved vertically to further judge the fit. Tightening knobs are large enough to be manipulated with animal handling gloves.

After the animal is in place, seat rungs are placed to accommodate hips and tail, and the leg restraint is arranged as needed. The respiration dome is seated last, confining head, shoulders and hand. The air flow rate upward through the dome is usually set at 500 ml/minute, and in our experience no $^{14}\text{CO}_2$ is lost downward through the upper support plate.

While most monkeys are easily restrained during their first experiences in the chair, confinement initially should be of short duration, and food rewards should be used during training, if experimental protocol permits.

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